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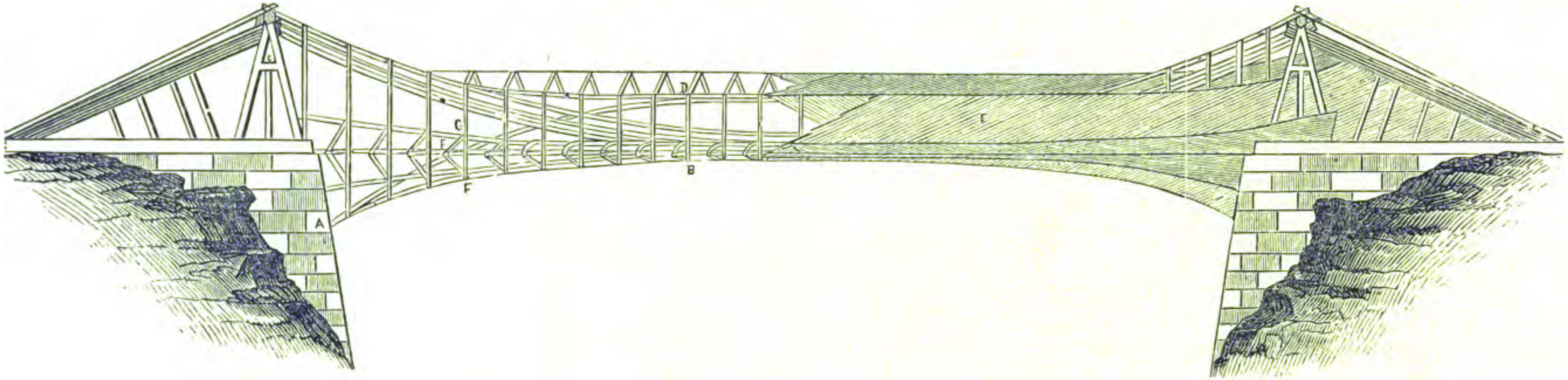
Eng

# WHITE'S WOODEN SUSPENSION BRIDGE.



①

From Bro. [illegible]
6 May, 1854.

Eng 748.52

# DESCRIPTION

OF A

# WOODEN SUSPENSION BRIDGE,

INVENTED BY

AMMI WHITE, BOSTON, MASS.

PATENTED FEB. 3, 1852.

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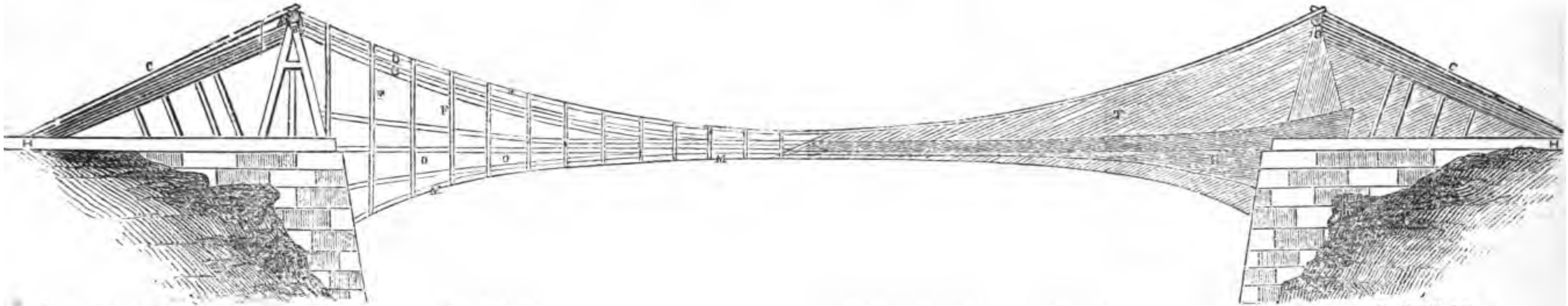
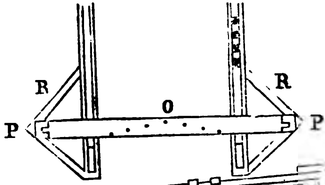
CAMBRIDGE:
JOHN FORD & CO., CHRONICLE PRESS.
1852.

FIGURE I.—THE BRIDGE WITHOUT ROOF.



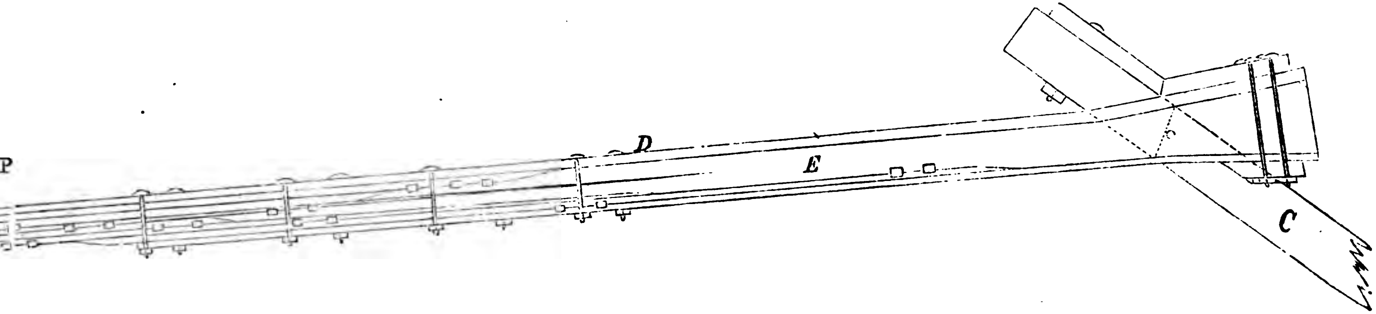
O. O. Floor Joists.
C. C. The Backstays.
T. Side Boarding.
D. D. The Stringers.
R. Boarding of the Side Guard.
F. F. Suspension Rods.
B. B. The Towers.
M. M. Direct Arch.

FIGURE II.—CROSS SECTION OF THE BRIDGE.



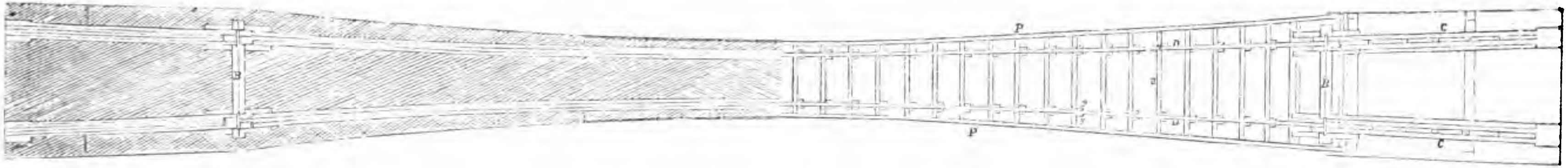
R. R. Side Guard Rafter.
P. P. Fender Raves.

FIGURE III.—SHOWS THE CONSTRUCTION OF THE STRINGER.



C. The Backstay.
E. The Butt of the Log which receives D.—the Splicing.

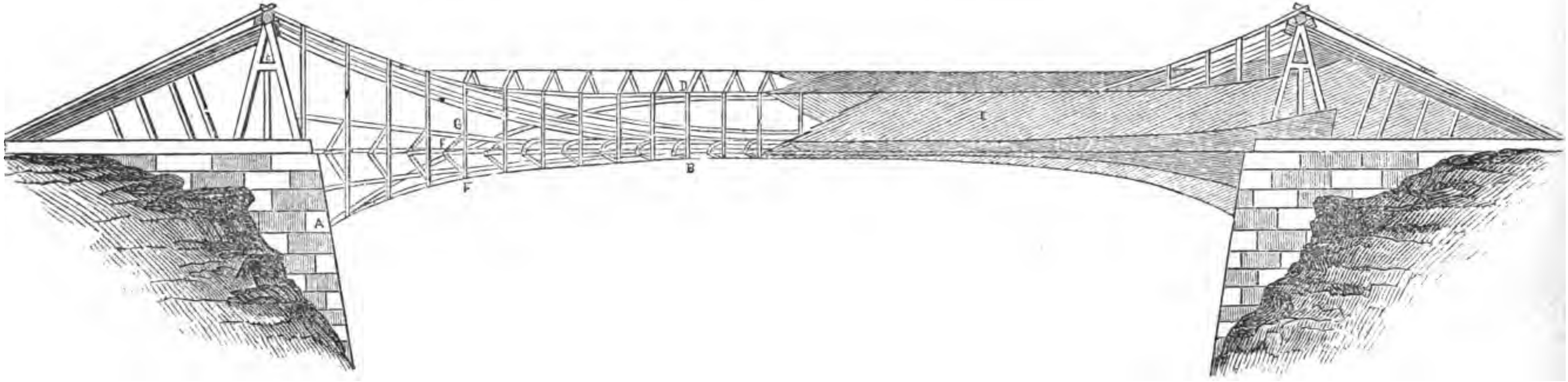
FIGURE IV.—THE ROAD BED.



B. B. Tops of Towers.

P. P. Fender Raves.

FIGURE V.—THE BRIDGE WITH ROOF.



1862, Aug. 19.
Gift of
Mrs. Catharine H. Harris,
of Cambridge.

# WHITE'S SUSPENSION BRIDGE.

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## I.—PRELIMINARY.

It is no light thing, in these days, to discover such a new application of mechanical and philosophical principles to the purpose of bridge-building, as to supercede the great variety of excellent inventions in use upon our innumerable rivers; and whoever claims to have done this is worthy of a candid and patient hearing. This, however, is precisely what is claimed for the invention under consideration.

Where the waters of a river are shallow and sluggish, and the danger from floods and ice is small, the most primitive methods of construction are in general sufficient — a few piles with connecting beams and plates being all that is necessary for the support of a road bed. Deepen the waters and add swiftness to the current, and piles must give way to solid piers, very costly in their construction, and the more expensive as the waters are deeper and the road level higher, until at length the cost of the piers would be more than the bridge is worth.

For such places, and in general, where piers are much exposed, or cannot for various reasons be built, some form of bridge must be adopted which dispenses with their use; hence the invention of arched, suspension and tubular bridges. The usual suspension bridge, whether hung upon wire cables or chains, as well as that known as the tubular bridge, belong to countries where iron is cheap and abundant, and wood scarce and dear; moreover, the iron suspension bridge, as at present constructed, is useless for railroad purposes.

The abundance and cheapness of timber in the United States, has led to the erection of many fine trussed and arched bridges; but we believe in no case has a greater span than that of the old bridge at Philadelphia, been attained, and this only at such an enormous cost as effectually bars their introduction where population is sparse and the amount of travel small.

The problem to be solved, then, is to combine the excellences of these various bridges — the firmness of one, the strength of another, the capacity for span of a third, the freedom of vibration of a fourth, &c., in one, which shall still be so economical in its construction as to be available, as well on a plank road in the wilderness as in the immediate neighborhood of a great city; in other words, the problem is to *span Niagara river* with a structure fitted for every kind of travel, and that, too, at an expense within reasonable limits. We venture to affirm that White's Suspension Bridge solves the problem fully—satisfactorily! This we shall endeavor to show by a careful and somewhat minute description of it.

As perhaps its most striking peculiarity is the application of the principle of the wire and chain bridges to one made of wood, so as to employ the *tensile* strength of that material, a preliminary word on this topic will not be out of place.

There are few who, at first thought, are willing to believe that the tensile or longitudinal strength of wood is actually greater than that of bar iron, in proportion to its weight; yet such is the fact. The weight of a cubic foot of bar iron is given in tables, founded upon actual experiment, as averaging a fraction over 486 lbs., and that of live oak at 70 lbs.,—giving a ratio of nearly 7 to 1. The *tensile strength* of a wrought-iron bar, one inch square, is put down at 60,000 lbs., and that of a bar of seasoned oak, of equal size, at 13,600 lbs.,—a ratio of less than 4 1-2 to 1. Thus a comparison of the weights and tensile strength of iron and oak, is largely in favor of the latter—the iron being nearly 7 times heavier, and less than 4 1-2 times stronger; in the case of seasoned red ash, the same weight of wood is actually double the strength of iron! It is clear, then, that there is no loss of strength in the adoption of wooden stringers instead of chains or cables of wire; while the cheapness of wood, and its freedom from the effects which changes of temperature produce in metals, are strong arguments in favor of it.

To the objection that nature furnishes no timber for homogeneous stringers, of more than a few yards in length, it is replied, that by splicing, as represented in figure III., where each separate piece is of carefully selected material, laid in oil cement, and held firmly in place by bolts and dowels, we obtain actually a greater strength than a beam of wood, of the same size, would possess, since, as the stringer is constructed in the curve it is intended to take, an equal strain is brought upon both surfaces.

## II.—CONSTRUCTION.

The abutments being ready—and such as are necessary for bridges of other constructions are amply sufficient for this—towers for the support of the stringers are firmly fixed upon them, and built of a height and strength corresponding to the length and weight of the proposed bridge. The stringers, made as is above intimated, by splicing boards to the butts of suitable logs, more or less in number, according to the span and strength required, and of such a length as to give the desired curve, are now raised to their places in the towers, and firmly locked and keyed to powerful backstays, which run backward and downward, and are properly secured in the ground, and to posts passing into the abutments. All the stringers necessary to one side are placed one above another, and each is locked to its own backstays, independently of the others. In small bridges, for common travel, the structure may be finished by simply dropping suspension rods, fastened to the stringers, and laying a road bed upon sleepers sustained by them.

For more important bridges, however, this is by no means sufficient. The bridge must be freed from vibration, both perpendicular and lateral, and strength and firmness be added to it without overloading the towers.

In case of a large bridge, where great firmness and rigidity is required, the towers must be placed at a distance apart, in a certain ratio greater than the width of the proposed structure at the centre. In the bridge of 500 feet length, of which a drawing is given, the distance between the towers is 30 feet, to a central width of 16 feet. It is obvious that in all railroad bridges the advantage of three sets of stringers (furnishing two road beds) in giving firmness to the structure, would far more than counterbalance the additional expense.

The stringers being in their places, and each set forming an inverted arch, the next step is to spring a direct arch under each of the inverted ones. These arches are constructed somewhat similar to the stringers, but the planks are cut into the proper curves and placed edgewise, so as to give the greatest possible resistance to a crushing force. These arches rest against the faces of the abutments, and may be single, double, or triple—may be entirely below the stringers, as in Figure I., or may throw one of its *bows* upwards to the top of the side, as in Figure V., as may in any case be most expedient.

The next step is to bring the stringers, which thus far hang loosely, into the exact position required, and while held by suitable mechanical appliances, the suspension rods are firmly bolted to the stringers, girders, and arches, and the floor joists, or sleepers, bolted with equal firmness to the suspension rods. These sleepers are made to project a certain distance beyond the sides of the bridge, and a fender rave is fitted to their extremities, from which spring short rafters, which at the same time brace the suspension rods and serve as the frame work of the side guards; the office of which is to offer farther security against any lateral oscillation during the passage of a train of cars. The object of attaining the greatest strength with the least dead weight, is never lost sight of, even in the smaller parts of the frame; hence instead of using heavy pieces of timber, the suspension rods are constructed of smaller pieces of selected material, put together as in case of the stringers; and for the same reason the sleepers, or floor joists, are formed of two planks, 12 to 15 inches in width by 2 1-2 to 3 inches in thickness, bolted together with two pieces of joist, placed between them in such a position that they rest, one on each of the bearings of the road bed, and meet in the centre, at the level of the planking, in an obtuse angle.

Here, then, we have the entire frame work of the bridge, very simple in its construction and the combination of its parts, yet of exceeding strength and firmness.

In order to overcome any remaining slight tendency to vibration, which might arise from a want of perfect solidity in the fastenings of the separate parts to each other, the stringers are loaded with a weight far beyond what they will ever be required to bear, and now, when the whole is thus firmly pressed and forced together, the structure is ready for covering. This in all ordinary bridges is a dead weight, which, while it protects the timbers, lessens by its weight the amount they would otherwise be capable of sustaining. In the bridge under consideration, on the other hand, the covering becomes an *essential element of strength*, and when to the sides and the road bed a roof is added, as in Figure V., the structure *becomes a tubular bridge*, capable of sustaining a heavy weight, even though both stringers and arches were removed. The novelty of the mode of covering adopted consists in this: that sides, roof and side-guards all are alike protected by a double boarding, of which the under stratum crosses the suspenders or rafters, as the case may be, diagonally, and the outer crosses the other at acute angles. From one extremity of the bridge, starting at the extreme points of the backstays, to the other, both outside, if thought necessary, and in, there is no break in this continuous double diagonal boarding. The planks of the road bed are also double throughout, and laid in the same manner. The immense strength attained by this mode of covering, can only be conceived of by those who are somewhat familiar with subjects of this nature. The results of experiments upon the strength of this mode of boarding are truly astonishing.

## III.—ADVANTAGES CLAIMED FOR THIS OVER OTHER BRIDGES.

1. *Superior Strength.* It is obvious that, strong as is this bridge, as it is above described, it may be strengthened to an almost unlimited degree by adding to the

number of stringers; and that the increase of strength is in far greater ratio than that of the weight and expense of the structure.

2. *Immobility.* In addition to what has been previously intimated on this point, it need be only remarked that vibration is almost impossible under any circumstances, in a structure which may be compared to two cones, fastened at their bases and meeting at their points; for every tendency to move, be it in what direction it may, meets with an insurmountable obstacle in some point of the spreading base.

3. *Length of Span.* To how great a length this bridge may actually be carried, it is impossible to say; it is clear, however, that bridges of any length at which it is possible to bring the stringers into place, may be built with perfect safety,—at all events, there is nothing to prevent the construction of bridges spanning rivers 12 to 1500 feet in breadth.

4. *Durability.* There being no large timbers liable to internal decay in any part of the bridge,—every separate piece used in constructing the stringers, suspenders, &c., being fully seasoned, and saturated with the oil of the cement,—the covering protected by fire-proof paint, and the entire structure raised above all danger from ice and flood,—it is not easy to assign any limit to the time which it may last and subserve the objects of its erection with perfect security.

5. *Economy.* The practical builder will readily perceive how materially the expense of constructing a bridge over broad and deep waters is lessened, by the absence of all necessity for the driving of piles, building of coffer dams, erecting piers, &c., and by avoiding all heavy timber work in the bridge itself. A bridge on the plan proposed in this pamphlet, will not only be comparatively economical, when its excellence is considered, but can actually be built for a much less first cost than any of the mere noted wooden bridges, to say nothing of any of the various structures of iron.

☞ Engineers, Agents and Directors of Rail and Plank Roads, Bridge Builders, and all interested in bridges, whose attention has been called to the invention herein described, and desire farther information, are respectfully invited to address either of the proprietors by letter, or to call and inspect the drawings and models, at their office, next door to the Athenæum building in Cambridgeport, Mass.

AMMI WHITE,
JOSHUA P. THAYER.

*April* 16, 1852.

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Description of a wooden suspensio
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